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GEOTHERMOGRAPH AND METEOROPHYTOGRAPH

by

St. Savin (Iasi)

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St. Savin (Iasi)

The paper gives the diagrams, the operating principle, and the field of implementation for two devices devised by the author to bring automation into agrometeorological observations, these being a geothermograph for continuous recording of soil temperature at various depths, and a meteorophytograph -- a complex device used for studying the phytoclimate (air and soil thermal regions, air moisture regions, atmospheric precipitations, and plant growth rate measured along circumference and in height).

Various types of apparatus and instruments are known for measuring the soil temperature. These include soil thermometers with mercury or alcohol (enclosed in glass), resistance thermometers based on the principle of resistance variation of metals to current flow as a function of temperature, and thermometers with thermocouples, which are a variation of resistance thermometers.

The basic disadvantage to these types of instruments consists of the fact that they are incapable of continuous recording of the soil temperature. This necessitates taking readings during interesting periods. Another disadvantage is their fragility; they require electrical installations with constant voltage, etc.

In order to avert these disadvantages, a recording apparatus was constructed -- a geothermograph. It allows continuous recording of the soil temperature with precision commensurate with the latest known instruments.

In agrometeorological work intended for the control of plant growth conditions, the observations and determinations are presently carried out with the classical meteorological apparatus and with biometrical measurements; each element is observed separately and at a designated time interval. The meteorophytograph -- a complex device -- was conceived for the automation of the observations and agrometeorologic determinations for the study of the phytoclimate. It allows for simultaneous recording of the principal phytoclimatic elements of the field.

Building a prototype, with experimentation and general use in agricultural production of the proposed apparatus, could contribute towards the dynamic determination of the main phytoclimatic parameters in the cultivation of plants. It would assure realistic data for the adaptation of agrotechnical measuring devices as a function of evolving agrometeorological conditions.

This work presents the diagrams, operating principle and the area of utilization of two apparatus conceived by the author for automatic agrometeorological observations in their respective regions.

The geothermograph records soil temperatures at various depths. The mechanism is relatively simple, easy to install and maneuver, and has a satisfactory accuracy. Its construction (Fig. 1) consists of a regular bimetallic plate, hermetically sealed within a metallic capsule. The very thin-walled capsule is covered with a lid which has an eccentric metallic center, on which one end of the bimetallic plate is rigidly attached. The remaining space between the center (eccentrically located) of the capsule's interior and its walls is greater towards the end which is not attached to

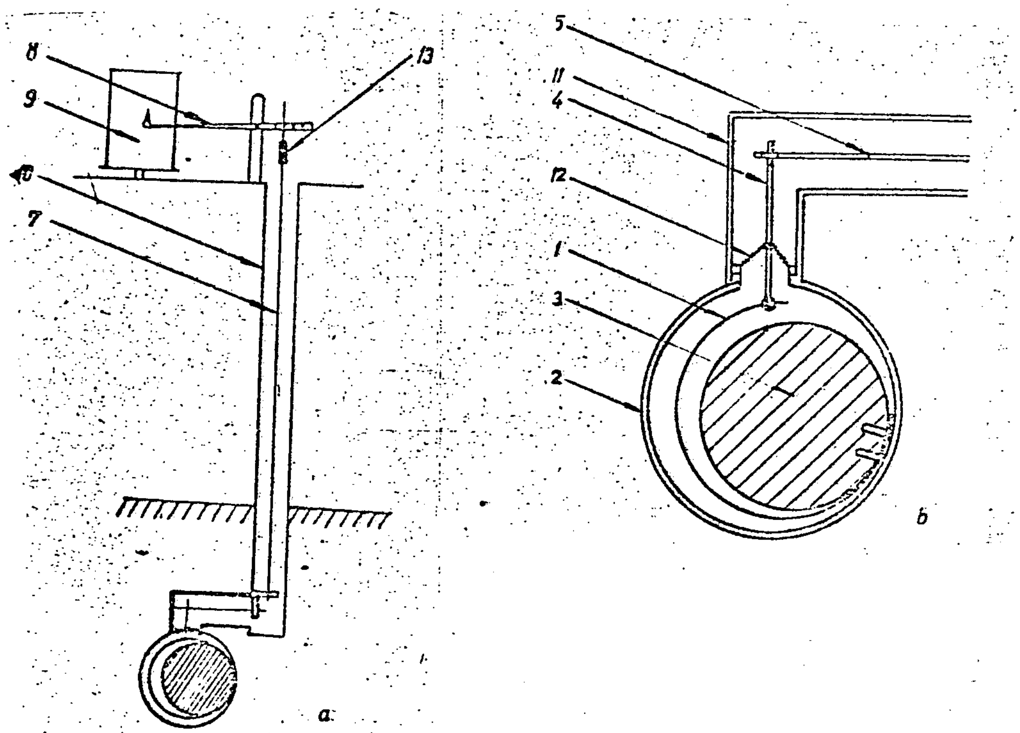

Fig. 1 (a, b): A diagram of the geothermograph.

Key:
1. Bimetallic plate
2. Protecting capsule
3. Eccentric center
4. Small rod
5. Lever
6. Foils, changing direction
7. Large rod
8. Plate with pen
9. Recording drum
10. Protecting tube
11. Mount of the rotating capsule
12. Rubber bag
13. Threaded socket (wheel box)

to the bimetallic plate. The variation in temperature produces varying deformations of the plate at the two ends (free and rigid). At the free end of the plate a small rod is attached. Its other end is attached to the lever and transmits the value of the bimetallic plate's deformation to foil which is capable of changing direction. The second, larger rod is attached to the foil at one end and to the end of the plate at the other, which amplifies the deformation value as a function of the joining point with the lever.

At the exit point from the the large rod's protective tube, a threaded gear (wheel) box is mounted which can modify its length by screwing in or unscrewing the respective rod. This controls the correct angle of the pen which is recording the apparatus's motion. From the protective tube, at the level of the foil capable of changing direction, extends another tube which protects the lever and the small rod. This tube is attached by screwing it into the mount on the upper portion of the capsule. The lid which contains the metallic center, eccentrically placed, is attached on the bottom of the capsule with two screws which pass through it and screw in at the center.

The free space in the capsule, where the bimetallic plate oscillates, is filled with mercury. At the capsule's opening towards the protective mount a small bag of thin rubber is attached.

The logging is done on a regular thermographic diagram. When the apparatus is used for various depths, the recording drum is dimensioned during its construction to accomodate the registering of all the diagrams corresponding to all the depth levels on which recording capsules were inserted.

The prototype constructed by the means available to the author was installed and operated experimentally in the Agrometeorological Section for a period of 30 days (20 April to 20 May 1966). Based on the observations by the Agrometeorological Section during this period, the following is noted: The apparatus operates normally; differences with respect to the soil thermometer (at the same depth -- 10 cm) in the limits 0.7 to 1.8°C at 7 AM and 0.0 to 1.3°C at 1 PM; the large frequency occurring between the limits of 0.8 to 1.6°C at 7 AM and 0.6 to 0.8°C at 1 PM. The deviations were only negative; the apparatus was submitted to the author for refinement, after which a new, rigorous observation period will be necessary.

From the observations obtained on the functioning of the apparatus, as well as its construction, it can be concluded that the apparatus operates within admissible error limits as determined during its construction and standardization in the specialized laboratories of the Meteorological Institute.

As a result of this verification, the improvement of the prototype under adequate conditions and with necessary materials will lead directly to assurance of a high degree of precision and certainty in obtaining data pertaining to the dynamics of soil temperature.

This fact would permit the generalized use of the apparatus, both in meteorological station networks as well as in agricultural practice, and in local service of seeding-type concerns.

Moreover, the apparatus can be mounted alongside others, thus assuring a complex of agrometeorological observations which can lead, with interpretation within a short period of time, to the adoption of measuring in practical agriculture.

The meteorophytograph serves in determinination and automatic recording of the growth rate of corn, together with the primary phytoclimatic factors, automatically drawing a graph with all the dynamic parameters.

These phytoclimatic parameters are as follows:

-- The air temperature at levels of 25 and 100 cm above the soil;

-- The air's relative humidity (at 25 and 100 cm);

-- Atmospheric precipitations (at 1.5 meters);

-- The soil temperature at varying depths.

In addition to indicating the corn's growth rate, the apparatus allows for the determination of the growth rate in height (the average of 4 standard plants) and also the growth in diameter at an established knot.

Based on established correlations through research on the interdependence between the above-mentioned parameters, agrotechnical measures can be adopted corresponding in function to the evolution of vegetation conditions.

The above-mentioned phytoclimatic parameters do not entail special apparatus differing from the known ones; the difference is only in the mode of adaptation to the base apparatus. The soil temperature measurement uses the geothermograph described earlier.

Located in the apparatus components as shown in Fig. 2 is a tall drum, 1 meter in height, and protected by a metal frame with a longitudinal slit facing the drum (the opening through which the recording pens extend).

The apparatus is installed vertically near the plant, on its north side.

On the lower part of the apparatus the geothermograph is mounted along with one or more receiving capsules corresponding to determined depths.

Mounted on the frame above the recording portion of the geothermograph are the thermograph and the hygrograph for the 20 cm level. Located above the first thermograph is the pluviograph (whose collecting funnel is mounted above the meteorophytograph at an altitude of 1.5 meters from the ground).

Also two recorders (a thermograph and a hygrograph) are installed on the upper portion of the recording drums, corresponding to a level of 100 cm. The thermographs and the hygrographs differ from the ordinary apparatus by having adapters on the carrying arms of the pens for the purpose of enhancing the amplification system.

The recording of the growth rate of corn is obtained with a fixed pen on the horizontal arm of a very light carriage which slides on three guide rods along the longitudinal opening through which the pen reaches the recording drum. The carriage is placed above the plant such that the horizontal

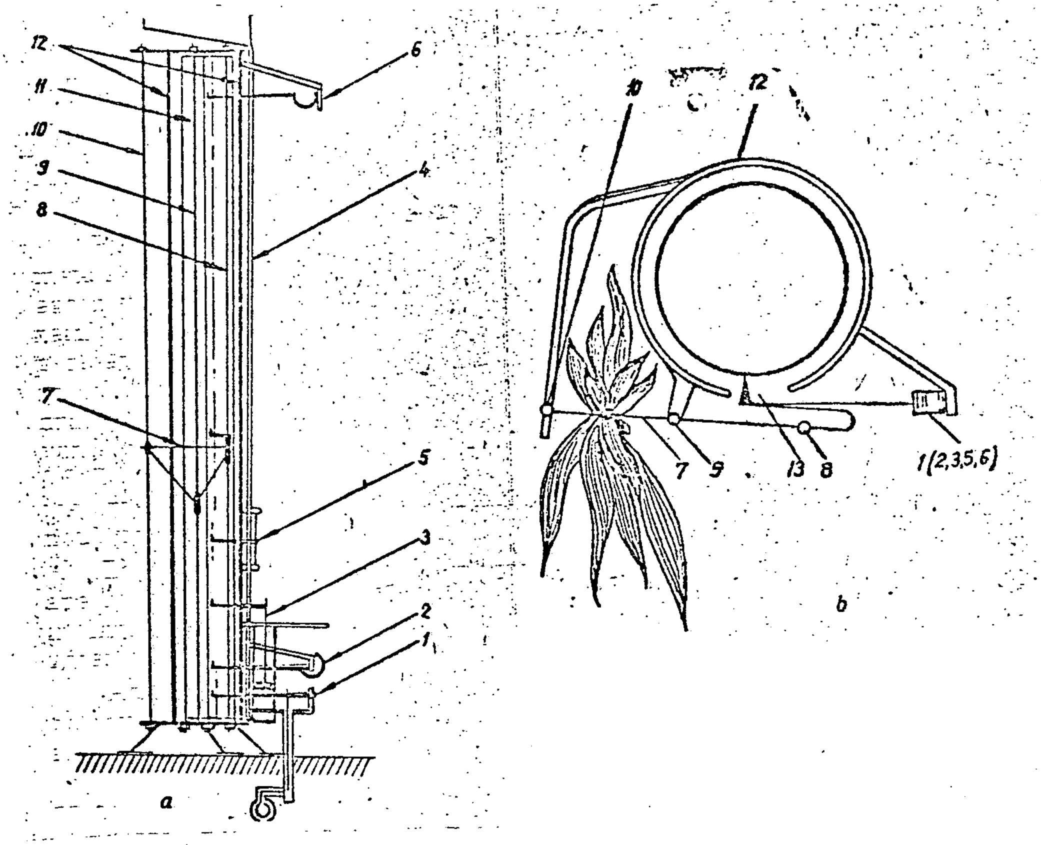

Fig. 2 (a, b): The diagram of a meteorophytograph.

Key: 1. Geothermograph
2. Thermograph I
3. Pluviograph (rain measure)
4. Pluviograph lead
5. Hygrograph
6. Thermograph II, hygrograph II
7. Truck
8, 9, 10. Guide rods
11. Drum
12. Protective case
13. Longitudinal opening of the frame, towards the pen

arm is exactly at the center where the leaves blossom (spread). Along with the panicle, at the location where the leaves detach, a small plastic funnel is installed. In this manner the plant raises the pen carriage by growing. From the panicle's inception, the carriage is attached to the base part of the panicle.

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